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PSYCHOPHYSIOLOGICAL CORRELATES OF HUMAN ADAPTATION IN ANTARCTICA

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SUMMARY

Problem

Previous research has pointed to social, psychological, and occupational characteristics of Antarctic station personnel as contributing to variations in emotional symptoms commonly experienced during the prolonged isolation of the winter-over period. However, little is known of the influence of specific personality characteristics and the severity of the station environment, either independently or in combination, on these symptoms.

Objective

This paper examines the social, psychological, and environmental correlates of the psychophysiological symptoms associated with wintering-over in Antarctica and the extent to which these correlates can be used to predict the severity of symptomatology during the winter-over period.

Approach

Subjects were 513 U.S. Navy enlisted men and civilian scientists and technicians assigned to six small U.S. Antarctic research stations between 1964 and 1974. Measures of depression, insomnia, hostility, and anxiety were elicited at the beginning and end of the winter-over period. Data on social and psychological characteristics of subjects were obtained at the time of screening for physical and psychological suitability for winter-over duty. Univariate analyses were employed to identify associations between social, psychological, and environmental characteristics and psychophysiological symptoms at the beginning and end of winter. Multivariate analyses were conducted to identify independent predictors of symptoms at the end of winter.

Results

Station latitude, altitude, mean annual temperature, were associated with depression and insomnia at the beginning of winter and depression, hostility,

INTRODUCTION

Ever since the days of the Belgica expedition of 1899 when the American physician, Frederick Cook, wrote of the "melancholy darkness" and "lethargy" of the winter-over crew (Sullivan, 1957), men and women who spend an entire year in Antarctica have experienced a number of mild to moderate psychophysiological disturbances after several months of winter confinement. These disturbances are manifested in symptoms such as insomnia, irritability and aggression, anxiety, depression, reduced motivation, gastrointestinal disorders, musculoskeletal aches and pains, and impaired cognition, including difficulty in concentration and memory, absentmindedness, and the occurrence of mild fugue states known as "long-eye" (Natani and Shurley, 1974). These symptoms appear to increase over time, peaking at mid-winter (Gunderson and Palinkas, 1988). Strange and Klein (1974) have grouped these symptoms into a general phenomenon known as the "winter-over syndrome."

While the winter-over syndrome represents a common response to the physical and psychosocial stressors associated with prolonged isolation in an extreme environment, there exist wide variations in the expression of this syndrome and the degree it adversely affects the health and performance of station personnel. Three sets of factors in particular appear to influence the process of psychosocial adjustment in all Antarctic research stations. The first is observed in individual traits in station personnel. According to Biersner and Hogan (1984), adjustment is a function of narrow interests and a low need for social stimulation. Being interested in many hobbies and activities consistently predicts poor performance "on the ice" (Gunderson and Nelson, 1965). Extroverts are less successful at adapting to this environment than more inner-directed, quiet, retiring types (Strange and Youngman, 1971). Characterized as "educated isolates," self-sufficient, intelligent,

calm, and independent, these individuals score higher on performance evaluations and report for sick call significantly less often than more group-centered personnel (Palmai, 1963).

Second, the different social, cultural and occupational characteristics of station members appear to influence patterns of adaptation and adjustment. American stations, for instance, have been staffed by Navy personnel and civilian scientists. Individuals also are distinguished by differences in socioeconomic status, particularly education and occupation. Navy personnel are further differentiated by rank and occupation. Age differences and, as more women begin to winter-over, sex differences also characterize the social groups of all stations.

These differences in social and cultural characteristics are evident in different coping styles, reflected in differences in health and performance. Navy personnel have been found to have lower job morale, a much higher incidence of insomnia and depression, and more than twice the average number of sick call visits than civilians (Doll and Gunderson, 1971a; McGuire and Tolchin, 1961). Civilians, on the other hand, reported more hostility than military personnel in early winter (Doll and Gunderson, 1971a).

Other factors besides military or civilian status appear to affect styles and levels of adjustment to the Antarctic environment. Older individuals with middle and upper-middle class backgrounds who are well-educated generally display fewer emotional and physical complaints while "on the ice" than younger, less educated personnel with lower or lower-middle class backgrounds (Gunderson, 1966).

Environmental conditions also appear to influence the experience of psychophysiological symptoms on the ice. Dyspnea, anorexia, insomnia, and headaches are frequent symptoms at all Antarctic research stations. Arterial

hypoxia, hyperventilation, and erythrocytosis are common in the high altitude environment of South Pole Station (Guenter, Joern, Shurley, and Pierce, 1970). The physiological changes incident to hypobaric hypoxia has resulted in several cases of acute mountain sickness with insomnia as a major symptom (Shurley, 1970). Changes in the immune system, experienced during the winter-over period (Bodey, 1974; Muchmore, Blackburn, Shurley, Pierce, and McKown, 1970; Williams, Climie, Muller, and Lugg, 1986), have been linked to an increased risk of affective disorders (Gold, Goodwin, and Chrousos, 1988). Research has also indicated that alterations of the hypothalamic-pituitary-thyroid (HPT) axis, found to occur among Antarctic winter-over personnel (Reed, Burman, Shakir, and O'Brian, 1986; Reed, Ferreiro, Shakir, Burman, and O'Brian, 1988) are associated with depression (Zach and Ackerman, 1988).

Although these three sets of characteristics are believed to influence the variations in emotional symptions associated with the "winter-over syndrome," several questions remain unanswered. First, previous research on the relationship between individual personality traits and criteria of adaptation and adjustment have found that personality traits which predict for successful adaptation in one subgroup of winter-over personnel fail to predict for adaptation in other subgroups (Gunderson, 1974). Moreover, the same personality trait does not necessarily predict for all measures of adaptation (Doll, Gunderson, and Ryman, 1969).

Second, despite previous research on the physiological changes experienced by personnel, we know little of the environmental factors which contribute to symptoms of depression, anxiety, hostility, and insomnia. Although extensive research on sleep loss has been conducted at the South Pole (Natani, Shurley, Pierce, and Brooks, 1970; Shurley, 1974), little is known about patterns of insomnia at other stations and the environmental

determinents of these patterns. Apart from studies conducted by Rivolier and his colleagues of personnel at French stations (Rivolier and Perrier, 1966; Rivolier, 1974), the association between environmental conditions and psychological symptoms and physical complaints in Antarctica has not been specifically addressed in previous research. If, as has been suggested elsewhere (Palinkas, 1987a; Bluth, 1987) we are to use Antarctica as an analog for long-term missions in space, we need to determine which symptoms are a product of the unique environmental features of Antarctica and which are associated with prolonged isolation.

Third, the relative contribution of each of these social, psychological, and environmental influences on symptomatology is unknown. Univariate models used in previous studies have pointed to associations between personality traits, social and occupational characteristics, and emotional stability (Gunderson, 1974). However, multivariate models could be employed to identify the independent relationship between each of these variables and the symptoms during the austral winter.

The object of this paper is to examine the social, psychological, and environmental correlates of the psychophysiological symptoms commonly associated with the winter-over syndrome to determine the extent to which these correlates can be used to predict the severity of symptomatology during the winter-over period.

METHODS

Subjects

The subjects were 358 Navy enlisted men and 155 civilian scientists and technicians assigned to one of six U.S. Antarctic research stations for a one year period between 1964 and 1974. All were volunteers who had been selected for Antarctic duty primarily on the basis of occupational expertise.

Measures

Psychophysiological symptoms: Four symptom scales were derived from self reports of mood at the beginning and end of winter. The Depression scale consisted of two items: (a) feeling blue and (b) feeling lonely. The Insomnia scale consisted of three items: (a) difficulty falling asleep or staying asleep, (b) waking up at night, and (c) feeling tired during the day. The Hostility scale consisted of the following two items: (a) feeling easily annoyed or irritated and (b) feeling critical of others. The Anxiety scale contained three items: (a) feeling nervous and tense, (b) inability to concentrate, and (c) feeling uneasy or worried.

A 4-point response scale, ranging from "not at all" to "severely," was used for these items. The scale scores were the sums of the response values: high scores indicated severe experiencing of the symptoms. Intercorrelations of the scales ranged from .19 to .46 in early winter and between .21 and .53 in late winter.

Personality characteristics: The personality characteristics and interpersonal needs of study subjects were measured by two scales which were originally employed to screen prospective candidates for winter-over duty during this period and to predict for performance on the ice. The first inventory was the FIRO-B (Schutz, 1958), designed to assess how an individual acts in three areas of social interaction in terms of the behavior the individual expresses towards others (expressing) and how he wants others to behave towards him (wanting). The six scales may be characterized as follows: Inclusion-Expressed (participating in group activities); Inclusion-Wanted (desiring to be included in group activities); Control-Expressed (controlling others, expressing dominance and leadership); Control-Wanted (wanting direction or regulation from others); Affection-Expressed (being affectionate with

others); and Affection-Wanted (wanting affection from others). A score on each subsection of the FIRO-B can range from 0 to 9. Across various adult groups sampled, the FIRO-B items have shown an average internal consistency (coefficient α) of .94. As to stability, Schutz (1967) reported a mean coefficient of the six scales of .76.

The remaining test scales and rating measures utilized in the study were developed especially for the Antarctic screening program on the basis of qualities believed to be desirable in winter-over personnel (Ford and Gunderson, 1962). Factor analysis was employed to identify highly intercorrelated clusters of inventory items which appeared to represent meaningful psychological concepts (Gunderson and Mahan, 1966). Four of the test scales measured common psychological needs: Achievement, Autonomy, Nurturance, and Order. The content of these four scales are generally similar to those of the corresponding *Edwards Personal Preference Schedule* (EPPS) scales (Edwards, 1959), although the format of the items was entirely different. In order to avoid problems with the ipsative nature of the EPPS scales, the need scales were presented as single items to be evaluated on six-point scales ("strongly agree" to "strongly disagree"), and response values were summed from highly intercorrelated items. Unlike the EPPS measures, a high score on the Antarctic scales indicated a low need for a particular trait. In this study, however, the scales were reversed to conform with the FIRO-B measures so that a high score on all ten scales reflected a high need.

Station environment: Environmental characteristics of the six stations are described in Table 1. Three specific environment scales were developed on the basis of ranges in altitude, latitude, and mean annual temperature. These characteristics were also integrated to create an environmental severity score for each station, ranging from 1 (benign) to 5 (extreme).

Table 1 about here

Social characteristics: Three specific social characteristics of winter-over personnel were examined: age, education, and military/civilian status. These characteristics were selected on the basis of previous studies which have found them to be associated with adaptation and performance during the winter-over period (Gunderson, 1974; Natani and Shurley, 1974).

Procedure

Information on the social characteristics of winter-over volunteers was obtained at the time of screening for the Operation Deep-Freeze program. Screening was typically conducted during the late spring and early summer months prior to deployment to Antarctica. All subjects were administered personality inventories at this time.

Self reported data on presence and severity of changes in mood and behavior were obtained from questionnaires administered on two occasions during the year of duty in Antarctica. The first administration occurred early in the period of winter isolation (March) and the second near the end of the winter isolation (September).

Data Analysis

Chi-square analysis and t-tests were used to examine differences in social characteristics of subjects by station. A repeated measures analysis of variance was performed to determine if symptom scores changed significantly during the course of the winter for either military or civilian personnel. Pearson product-moment correlations were performed on all of the variables to identify associations between each of the symptoms and the selected measures of station environment and personnel social and personality characteristics.

Stepwise multiple regression analyses were performed to assess the overall relationship between environment, personality characteristics, and social characteristics and each of the four psychophysiological symptoms as reported at the end of the winter. In order to determine the extent to which these variables could be used as predictors of adaptation to prolonged isolation, the symptom as reported at the beginning of the winter was also included in each analysis.

RESULTS

Descriptive statistics of the social characteristics of the entire study sample and by station are provided in Table 2. Two-thirds of the total sample were military personnel; three-fourths possessed at least a high school diploma. A comparison of subjects by station revealed significant differences in age ($F=3.62$, d.f. = 5,497, $p = 0.003$) and education ($x^2 = 25.86$, d.f. = 10, $p < 0.004$). Subjects who wintered-over at the station with the most extreme environment, Plateau, had the lowest mean age (24.4) and the highest percentage of personnel with 12 or more years of education (100.0%).

Table 2 about here

A comparison of the four symptoms by time and military/civilian status is provided in Table 3. The severity of all four symptoms increased significantly over the course of the winter-over period. When the subjects were divided into military and civilian groups, military personnel reported significant increases in all four symptoms but civilian crewmembers reported significant increases only for hostility and anxiety.

Table 3 about here

In order to determine which environmental, social, and personality characteristics were associated with symptoms reported at the beginning and end of the winter-over period, Pearson-product moment correlations among all the variables of interest were calculated. Zero-order correlations with the four symptoms as reported at the beginning of the winter-over period are contained in Table 4. The environmental measures of latitude, altitude, and mean annual temperature were significantly associated with depression and insomnia. However, although these measures were positively associated with insomnia, they were negatively associated with depression. Station size was inversely associated with depression and hostility. Of the personality characteristics, a high need for autonomy was significantly associated with hostility and a need for nurturance was directly associated with depression. Age was inversely associated with depression, hostility, and anxiety. Education, on the other hand, was directly associated with hostility. Military personnel were more likely to be depressed and have sleep problems while civilians were more likely to report hostile feelings.

Table 4 about here

Environmental measures of severity and size were also inversely associated with reports of depression at the end of the winter, along with hostility and anxiety (table 5). Size and environmental severity, however, was unrelated to sleep problems by the end of the winter. A need for control by others was inversely correlated with depression and insomnia while a need for autonomy was directly related to hostility. Age was inversely associated and

education was directly associated with hostility. Education was inversely associated with depression and insomnia, however. Military personnel were more likely to experience symptoms of depression, insomnia, and anxiety at the end of winter than civilian personnel.

Table 5 about here

Given the large number of predictors, a series of stepwise multiple regression analyses was constructed to identify, in a preliminary way, the most important ($p < 0.05$) predictors of the four psychophysiological symptoms as reported at the end of the winter. Included in each of the analyses as an independent variable was the respective psychophysiological symptom as reported at the beginning of the winter. Zero-order correlations for the symptoms as reported at the beginning and end of winter were as follows: depression ($r = .49$, $p < 0.001$), insomnia ($r = .43$, $p < 0.001$), hostility ($r = .36$ $p < 0.001$), and anxiety ($r = .40$, $p < 0.001$).

Interaction effects between military and civilian status were also included in the analyses because product-moment correlations between personality scale scores and military/civilian status indicated significant associations between status and the measures of autonomy ($r = -.17$, $p < 0.001$), inclusion-expressed ($r = -.10$, $p = 0.028$), control-expressed ($r = .15$, $p = 0.001$), control-wanted ($r = .13$, $p = 0.003$), and affection-wanted ($r = .11$, $p = 0.013$). The interaction effect between personality characteristics and military/civilian status was tested by coding military/civilian status as a dummy variable and including each personality scale x military/civilian status as a cross-product.

Using the standardized betas, Table 6 summarizes the strength of the association between the environmental, social and psychological characteristics which contributed significantly to the prediction of the four symptoms. Between 21 and 30 percent of the variance in symptom scores were accounted for by the full models. The respective symptom score at the beginning of the winter was a significant independent predictor of all four symptoms. Environmental severity contributed significantly to the prediction of hostility and anxiety; however, the more severe the environment, the less severe the symptoms. Military status predicted for insomnia. A low score on the FIRO-B measure of the need to be controlled by others predicted for depression. A high score measuring the need for autonomy predicted for hostility. A high score on the need to express affection and a low score measuring the need for affection from others contributed significantly to the prediction of anxiety.

Table 6 about here

DISCUSSION

In the Antarctic, symptoms of depression, insomnia, hostility, and anxiety are believed to represent the adaptation and exhaustion stages of Selye's (1956) general adaptation syndrome (Popkin, Stillner, Osborn, Pierce, and Shurley, 1978). Haggard (1964) concluded that men usually cannot adapt to extreme or extended isolation without showing some of the symptoms that typically characterize the mentally ill, suggesting that the absence of familiar, meaningful objects and relationships, as well as the presence of the unfamiliar produces the disturbances associated with isolation. Moreover, these disturbances are usually restricted to the station itself. A long-term follow-up study by Palinkas (1986) found no adverse effects of

winter-over duty on the physical or mental health and performance of enlisted Navy personnel. In fact, winter-over personnel were found to have significantly fewer total first hospitalizations subsequent to their Antarctic duty than a control group of enlisted personnel who were accepted for Antarctic duty but who did not winter-over.

All four symptoms increased significantly during the course of the austral winter. This increase was also found in previous studies of this population (Gunderson, 1974; Gunderson and Palinkas, 1988). However, the results of this study expand upon the earlier research in two important respects. First, significant independent contributions to the prediction of this increase were made by the symptoms as reported at the beginning of winter, which suggests that a substantial amount of adaptation to the Antarctic environment occurred prior to the austral winter. Second, the results suggest a pattern of adaptation in which a number of factors, including the station environment, social characteristics of station personnel, and individual psychological characteristics, interact in a particular fashion to influence the severity of each of these symptoms. Each of these influences will be examined in turn.

At the beginning of winter, sleep disorders were significantly associated with environmental conditions. Shurley (1974) postulated that sleep disorders at the South Pole represented the gradual depletion of some biochemical factor during chronic stress associated with hypobaric hypoxia along the lines of Selye's (1956) general adaptation syndrome. An alternative explanation, according to Shurley, is that the disorders may be due to a depression in hypothalamic function caused by the absence of sunlight which, in turn, would diminish the pituitary secretion of human growth hormone, whose release is known to be associated with the onset of stage 4 sleep (Sassin,

Parker, Mace, Gotlin, Johnson, and Rossman, 1969). The absence of this association between sleep disorders and environmental conditions at the end of winter suggests that some adjustment to the environmental stressors had occurred, even though symptoms had increased significantly among military personnel.

Environmental conditions were also associated with depression at the beginning of winter and depression, hostility, and anxiety in late winter. Environmental severity was also found to be a significant independent predictor of hostility and anxiety at late winter. However, the more severe the environmental condition, the less severe the symptom. As with insomnia, some form of adaptation to these environmental conditions appears to be taking place, although the precise nature of this adaptation remains to be determined. The consistent inverse association between the environmental conditions and depression both early and late winter indicates that whatever form of adaptation associated with this symptom occurs earlier than adjustments associated with the other three symptoms. This may possibly be a function of the expectations of station members prior to deployment to Antarctica. Ethnographic research conducted at McMurdo and South Pole stations in October and November, 1988, found that station members are told to expect a certain amount of depression during the winter period. The more the environment conforms to the expectation of the winter-over candidate that he or she will be confined in a harsh environment with a small crew, the less depressed the individual may be. Additional research is required to examine this hypothesis, however.

A measure of the social environment, station size, was also inversely associated with depression and hostility at early winter and anxiety at late winter. Station size has been found to be inversely associated with self

reports of hostility and measures of group compatability and group achievement in previous studies of this population (Doll and Gunderson, 1971a, 1971b).

However, the associations between the psychophysiological symptoms and station size and physical environment may be confounded by the social characteristics of personnel assigned to each station. As indicated by the results in Table 2, the six stations differed significantly with respect to the age and education of their winter-over personnel. Age was inversely associated with depression and anxiety at the beginning of winter and hostility throughout the winter. The inverse association between age and depression has been observed in non-isolated populations as well (Weissman and Myers, 1978).

Similarly, education was inversely associated with self reports of insomnia and depression at the end of winter but positively associated with hostility throughout the winter period. Ethnographic research conducted this past year indicated that the better-educated scientists and technicians had greater flexibility in setting their own work schedules and altering their sleep patterns accordingly than less educated military and civilian support personnel and, consequently, experience less desynchronization resulting from the lack of environmental cues. Desynchronization has also been associated with depression (Kripke, 1985).

Education was also significantly correlated with military/civilian status ($r = .62$, $p < .001$), which might explain why the latter but not the former characteristic was found to be an independent predictor of insomnia. Results of this study also indicate that civilian personnel were more hostile than military personnel at the beginning of winter. This was observed in an earlier study by Doll and Gunderson (1971a) as well. In contrast to the earlier study, however, our results indicated that military personnel

reported more sleep problems and greater anxiety in late winter than civilians. Furthermore, measures of all four symptoms increased significantly over time in the military personnel. Among the civilians, significant increases in hostility and anxiety were reported by the civilians. Civilians, therefore, appear to have better adapted to conditions associated with depression and insomnia than the military personnel.

These differences in symptom patterns among military and civilian personnel may be the result of different personality traits which previous studies have found serve as predictors for performance and emotional adjustment in the two groups (Doll, Gunderson, and Ryman, 1969). Military personnel scored lower on measures of the need for control (both expressed and wanted), autonomy, and affection from others, and higher on the measure of inclusion of others, than civilian personnel. Three of these measures--control-wanted, autonomy, and affection-wanted--were significantly associated with different symptoms. The desire for control by others, autonomy, and affection (both expressed and wanted) were also significant independent predictors of symptoms at the end of winter.

In addition to the military-civilian differences in personality characteristics, different psychological needs were associated with, or independent predictors of, different symptoms. Thus, although the four symptoms may be interrelated, they are not uniformly influenced by the same psychological characteristics. The need for autonomy was a risk factor for hostility throughout the winter. A need for nurturance was associated with increased symptoms of depression at the beginning of winter. A need to express affection for others predicted increased anxiety at the end of winter. During the prolonged isolation of the Antarctic winter, the opportunities to meet these needs are extremely limited. Crew members are pre-

vented by the confined environment, leadership structure, and group norms from exercising autonomy with respect to work and recreational activities. Nurturance and affection, usually provided by family and friends back home, are rarely given by other station members. Moreover, the sociocultural systems of Antarctic research stations during this period discouraged displays of affection among members of all-male crews.

On the other hand, the need for affection from others indicates an openness to social interaction with members of a confined social group and hence might be viewed as an adaptive trait for individuals in a confined social group; hence the inverse association with anxiety. Similarly, the need to be controlled by others would appear to be adaptive in a setting where one's behavior is dictated by the environmental circumstances, authoritarian leadership structure of the military, and group norms. In other words, needs which are supported by the physical and social environment appear to reduce the risk of psychophysiological symptoms; those needs which are not supported by the environment appear to increase the risk of these symptoms.

Differences in severity of symptoms on the basis of military and civilian status and certain personality measures also point to the importance of perceived control over one's social and physical environment during the winter-over period. An earlier study (Palinkas, 1988) hypothesized that personnel who perceived themselves to be powerless because they cannot exercise control or autonomy in either a social or a psychological sense have the greatest difficulty in adjusting to the demands imposed by the Antarctic environment. This would include military personnel who are subject to a more authoritarian organization and perceive themselves to be subordinate to the more autonomous, better educated civilian scientists. It would also include

personnel who have a high need for autonomy in a social and physical environment over which the individual station member has little control. The results of this study suggest that these individuals are less likely to adapt to the prolonged isolation and extreme environmental conditions than individuals who either have control or autonomy by virtue of their work assignments (i.e., civilian scientists and technicians), or who have a low need for autonomy and a high need to relinquish responsibility for control over their lives.

The constraints on autonomy and control over the physical and social environment may also help to explain why a low need for affection from others and a high need to express affection to other station members independently predict for anxiety at the end of winter. Affection-expressed refers to the initiation of a relationship with another individual while affected-wanted refers to eliciting behavior from others. In the social context of an isolated Antarctic research station, initiating and eliciting affection from others may fall along the lines of a superordinate-subordinate dimension with the superordinate individual exercising responsibility in initiating the relationship and the subordinate individual eliciting behavior from others. This association is suggested by the weak, but significant correlation ($r = .11$, $p < 0.01$) between control-wanted and affection-wanted in our study sample. Thus, the need to initiate intimate relations in a sociocultural setting where one is expected to be emotionally self-sufficient (Palinkas, 1988; Taylor, 1974) may thus be interpreted as wanting to control one's social environment while the need to elicit behavior from others may be interpreted as a desire to be controlled by others. However, further research is required to determine if intimate relations in a confined social

group are indeed viewed in terms of the ability to control one's social environment.

Three limitations must be addressed when evaluating the results of this study. First, the research design of this study was largely exploratory and observational in nature. More rigorous methods are required to test the hypotheses suggested by the results.

Second, no adjustment was made for the multiple comparisons tested between each of the independent variables and the four symptoms. Consequently, a certain number of significant associations are expected to occur on the basis of chance alone. Caution must be exercised, therefore, when evaluating the results.

Third, the associations between social and psychological characteristics and the four symptoms may be specific to the sociocultural background of the subjects studied (i.e., U.S. Navy enlisted personnel and civilian scientists) and to the sociocultural systems of United States Antarctic Program research stations. Cultural differences in the appraisal of stress and the expression of stress-related symptoms (Palinkas, 1987b) may result in different patterns of symptom expression associated with different sets of personality and social characteristics than the ones observed in this study. Research conducted at Antarctic stations operated by other treaty nations is recommended to determine how differences in the cultural background of station personnel and in the cultural systems of the stations themselves influence the associations between social and personality characteristics and psychophysiological symptoms.

Despite these limitations, these results suggest that many of the physical and psychological symptoms experienced by winter-over personnel are influenced by environmental conditions, particularly at the end of the

winter. However, this influence is, in general, a positive one, reflecting some form of adaptation to the prolonged isolation and extreme environment. This adaptation appears, in turn, to be related to the possession of certain personality needs or traits which are satisfied by existing social and environmental conditions and the relative absence of needs or traits which the environment cannot satisfy. Consequently, the reduction of symptoms commonly experienced during the austral winter in Antarctica may be accomplished by assigning to stations characterized by high latitude, high altitude, and extreme cold those older, civilian personnel who score low on measures of autonomy, nurturance and expressed affection and high on measures of wanted affection and control by others.

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Table 1. Characteristics of Station Environments

	Station					
	Palmer	Hallett	Eights	Byrd	South Pole	Plateau
Terrain	bedrock	glacial moraine	inland ice	inland ice	inland ice	inland ice
Latitude	64°45'S	72°19'S	75°15'S	79°59'S	90°S	79°30'S
Altitude (meters)	8	5	1,380	1,530	2,835*	3,624
Mean annual temperature (°C)	-7	-15	-24	-27	-46	-52
Average No. of winter personnel per year (1964-1974)	9	14	11	27	20	8

* Mean annual barametric pressure at South Pole Station is around 500mm Hg (680 milibars) and the mean pressure altitude is equivalent to approximately 3,350 meters.

Table 2. Social and Demographic Characteristics of Winter-over Subjects by Station

Characteristic	Total Sample (N=513)	Station					
		Palmer (N=79)	Hallett (N=11)	Eights (N=23)	Byrd (N=190)	South Pole (N=196)	Plateau (N=14)
Mean Age	26.9	26.9	27.9	30.4	26.2	27.3	24.4
Education	%	%	%	%	%	%	%
LT 12 years	24.2	19.0	54.5	39.1	24.7	24.0	0.0
HS Grad	49.1	60.8	45.5	39.1	52.1	42.3	57.1
College	26.7	20.2	0.0	21.7	23.2	33.7	42.9
Occupation							
Military	69.8	78.5	100.0	60.9	68.9	66.8	64.3
Civilian	30.2	21.5	0.0	39.1	31.1	33.2	35.7

Table 3. Psychophysiological Symptoms by Time and Occupational Status

		Early Winter	Late Winter	
	N	Mean (S.D.)	Mean (S.D.)	F ratio
Total Sample				
Depression	421	3.63 (1.31)	3.84 (1.38)	10.51***
Insomnia	417	5.50 (1.85)	5.95 (2.01)	20.07***
Hostility	421	3.55 (1.14)	4.24 (1.29)	105.11***
Anxiety	417	4.45 (1.48)	5.10 (1.74)	55.55***
Military Personnel				
Depression	294	3.78 (1.33)	4.01 (1.42)	8.31**
Insomnia	292	5.65 (1.94)	6.23 (2.02)	21.35***
Hostility	295	3.49 (1.13)	4.16 (1.32)	64.31***
Anxiety	290	4.52 (1.53)	5.21 (1.80)	37.57***
Civilian Personnel				
Depression	127	3.26 (1.19)	3.43 (1.19)	2.24
Insomnia	125	5.13 (1.57)	5.29 (1.81)	0.93
Hostility	126	3.69 (1.16)	4.43 (1.20)	43.70***
Anxiety	127	4.28 (1.35)	4.85 (1.59)	19.25***

* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

Table 4. Zero Order Correlation Coefficients of Symptoms at Beginning of Winter and Station Environment, Personality, Sociodemographic Characteristics, and Health-related Behaviors.

	Symptoms			
	Depression	Insomnia	Hostility	Anxiety
Station latitude	-.14**	.12**	-.03	-.02
Station altitude	-.11*	.18***	.05	<.01
Station mean temperature	-.10*	.17***	.04	<-.02
Station size	-.10*	<-.01	-.11*	-.02
Inclusion-expressed	-.07	-.01	-.09	-.05
Inclusion-wanted	.01	.06	.00	.09
Control-expressed	-.08	-.08	.03	-.06
Control-wanted	.05	-.07	.05	.05
Affection-expressed	.06	.02	-.03	-.01
Affection-wanted	.00	-.02	-.04	.04
Achievement	-.01	.00	-.05	-.08
Autonomy	.05	-.06	.24***	.09
Nurturance	.12**	.04	-.04	-.05
Order	.04	.01	-.02	-.01
Age	-.12*	-.03	-.11*	-.12*
Education	-.06	-.05	.15***	.04
Military/Civilian	-.16***	-.11*	.09*	-.06

* $p < 0.05$ (two tailed)
** $p < 0.01$
*** $p < 0.001$

Table 5. Zero Order Correlation Coefficients of Symptoms at End of Winter and Station Environment, Personality, Sociodemographic Characteristics, and Health-related Behaviors.

	Symptoms			
	Depression	Insomnia	Hostility	Anxiety
Station latitude	-.23***	-.04	-.17***	-.11*
Station altitude	-.22***	-.02	-.14**	-.10*
Station mean temperature	-.21***	-.03	-.14**	-.10*
Station size	-.16***	-.01	-.11*	-.11*
Inclusion-expressed	-.08	.02	.04	.03
Inclusion-wanted	-.04	.08	.08	.03
Control-expressed	-.03	-.06	.07	-.03
Control-wanted	-.13**	-.12**	.07	-.02
Affection-expressed	.03	.07	-.00	.06
Affection-wanted	-.02	.02	-.02	-.05
Achievement	-.01	-.05	-.02	.02
Autonomy	.04	-.03	.17***	.09
Nurturance	.08	.03	-.06	.04
Order	.04	-.01	-.07	.01
Age	-.04	.01	-.11*	-.04
Education	-.11*	-.17***	.10*	-.01
Military/Civilian	-.23***	-.22***	.06	-.10*

* $p < 0.05$ (two tailed)
** $p < 0.01$
*** $p < 0.001$

Table 6. Regression of Symptoms at End of Winter on Station Environment, Personality, Sociodemographic Characteristics, and Health-related Behaviors.

	Symptoms			
	Depression (beta)	Insomnia (beta)	Hostility (beta)	Anxiety (beta)
Condition at beginning of winter	.48***	.42***	.34***	.42***
Environment Severity			-.15**	-.18***
Control-wanted	-.11*			
Affection-expressed				.16**
Affection-wanted				-.24***
Autonomy			.10**	
Military/Civilian status		-.16***		
Full Model				
R_2	.53	.50	.46	.54
R^2	.28	.25	.21	.30
F	5.17***	4.37***	3.60***	5.49***
d.f.	26,347	26,344	26,347	26,345

* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

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This NSF-funded study examines the social, psychological, and environmental correlates of the psychophysiological symptoms associated with wintering-over in Antarctica and the extent to which these correlates can be used to predict the severity of symptomatology during the winter-over period. Subjects were 513 U.S. Navy enlisted men and civilian scientists and technicians assigned to 6 small U.S. Antarctic research stations between 1964 and 1974. Station latitude, altitude and mean annual temperature were associated with depression and insomnia at the beginning of winter and depression, hostility, and anxiety at the end of the winter. Environmental severity was an independent predictor of hostility and anxiety at the end of winter. Except for insomnia, however, the more severe the environment, the less severe the symptoms. Age was inversely associated with depression and anxiety at the beginning of winter and hostility throughout the winter. Education was inversely associated with insomnia and depression at the end of winter and positively associated with hostility throughout the winter. Military and civilian personnel differed (Continued on reverse side)

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with respect to the symptoms experienced and the personality traits enabling them to adjust to the prolonged isolation and extreme environmental conditions. Individual needs relating to autonomy, control and affection were significant independent predictors of different symptoms. Some form of adaptation to environmental conditions appears to be taking place with respect to psychophysiological symptoms. This adaptation, in turn, appears to be related to social characteristics of station personnel and the possession of certain social personality needs or traits which are satisfied by existing social and environmental conditions and the relative absence of needs or traits which the environment cannot satisfy.